Erosion effects on soil carbon and nitrogen redistribution

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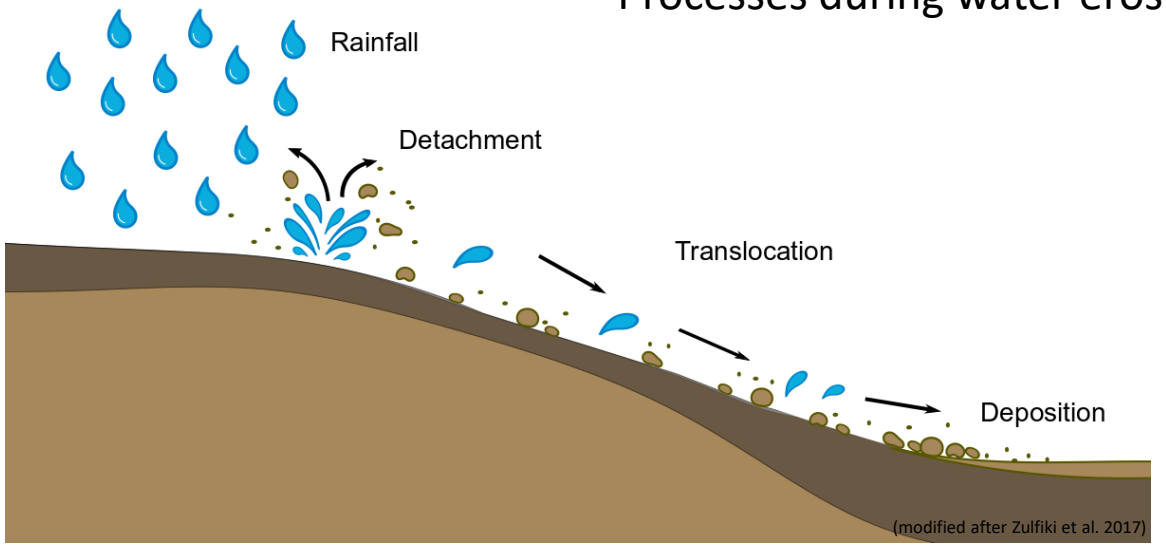
Relevance of soil erosion:

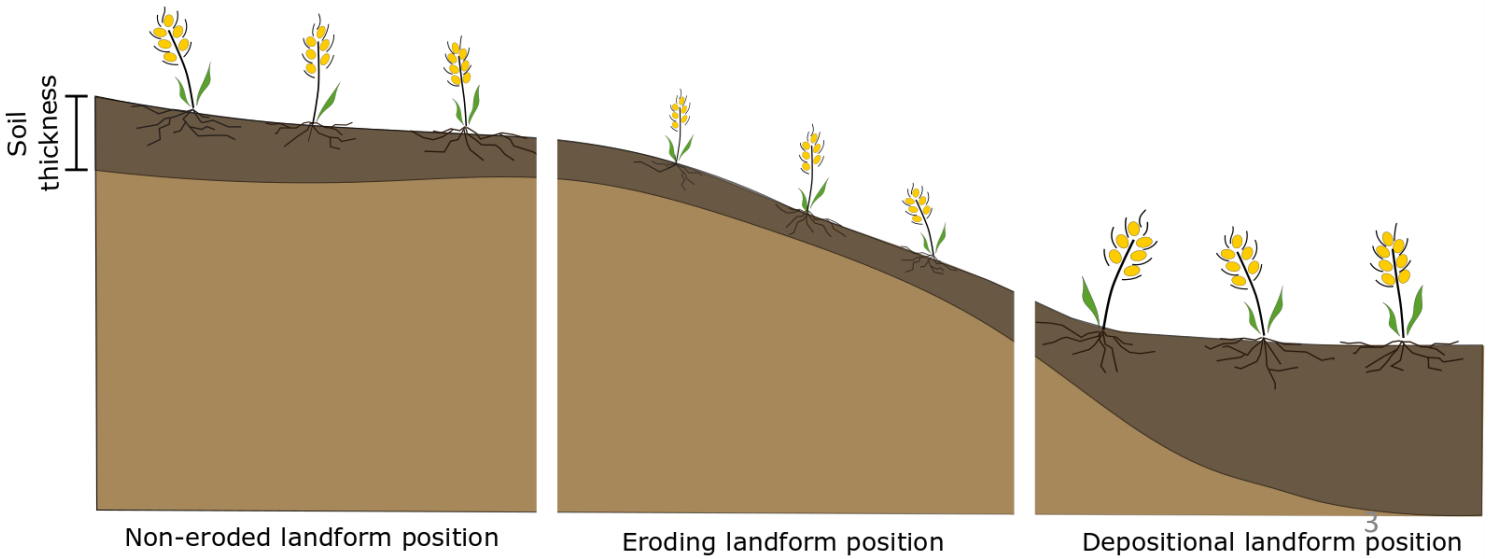
- Each year, 25,000 million tons of topsoil are removed by soil erosion → severe losses in soil fertility
- As soil is formed very slowly, soil losses are 13–40 times greater than the rate of soil renewal
- Water erosion accounts for 55% wind erosion to 33% and tillage erosion to 12%.

(LfULG, Sachsen)

Processes during water erosion



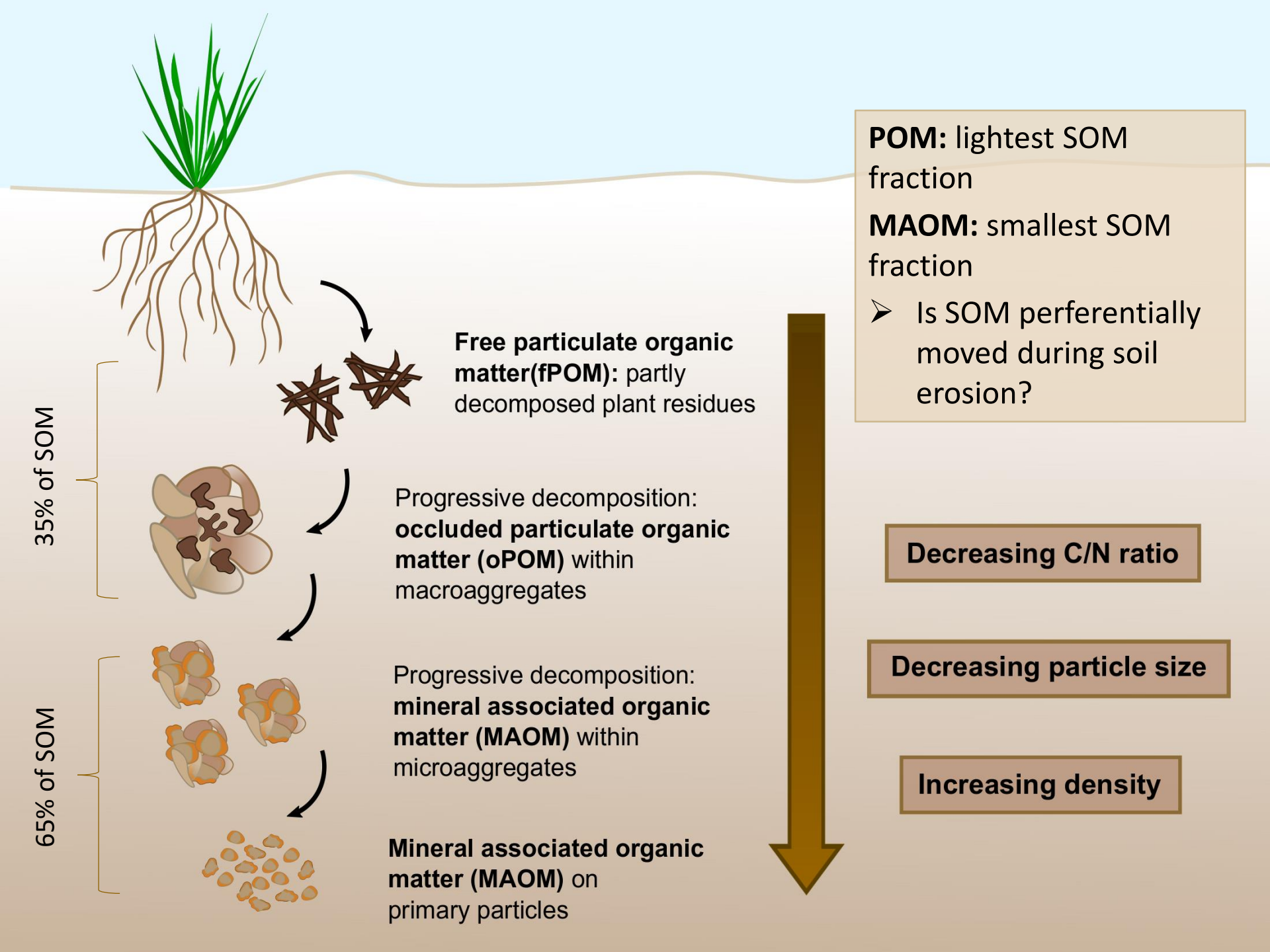
Properties of eroded slopes



- Quantification of soil loss alone is not sufficient to estimate reduction in soil fertility caused by erosion
- Most relevant for soil fertility is soil organic matter
  - ➢ Improves soil structure
  - ➢ Enhances soil water holding capacity
  - ➢ Serves as nutrient reservoir: e.g. 90% of soil nitrogen is stored in organic form

How does soil erosion affect soil organic matter redistribution ?

(www.thuenen.de)



POM: lightest SOM fraction

MAOM: smallest SOM fraction

- Is SOM perferentially moved during soil erosion?

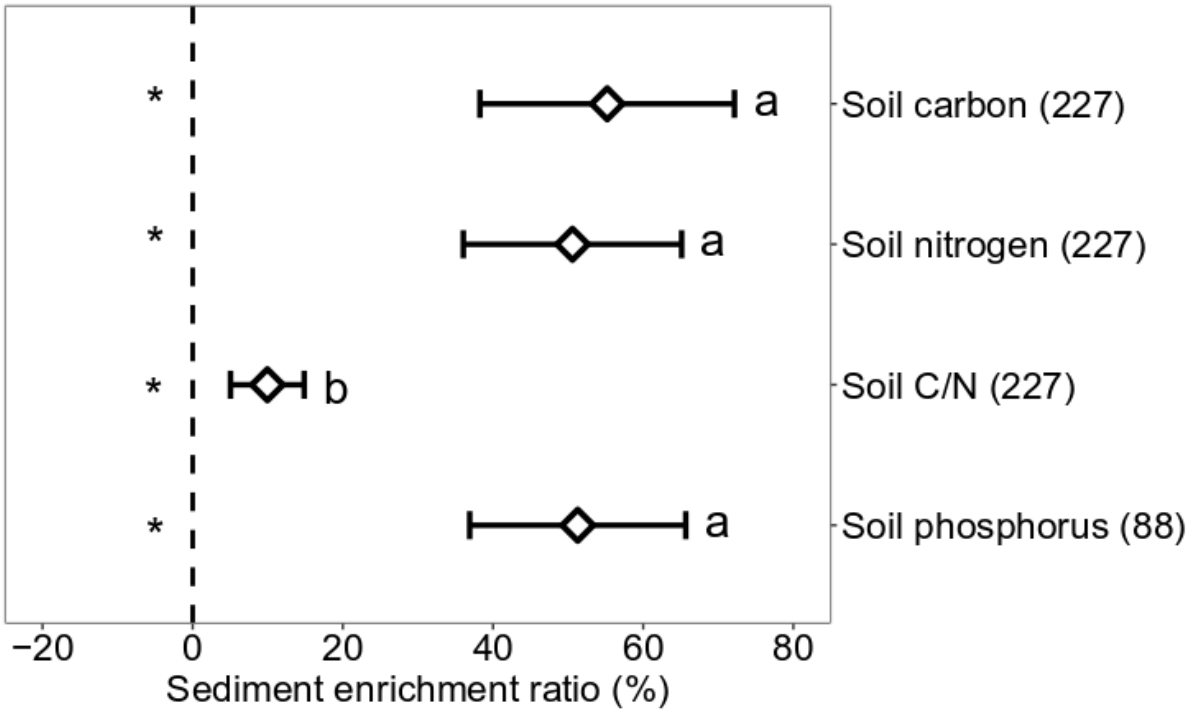
Meta-Analysis

- 29 studies from 14 countries quantifying C and N contents in eroded sediments compared to the original soils (227 data points in total)
- Most studies conducted on runoff plots under field conditions
- Additional parameters: soil texture, land use, slope gradient

Runoff plot in the field

- ➢ Are soil C and N enriched in eroded sediments?
- ➢ Are there differences in enrichment between C and N?
- ➢ Which parameters explain enrichment of C and N?

C, N and P enrichment in eroded sediments



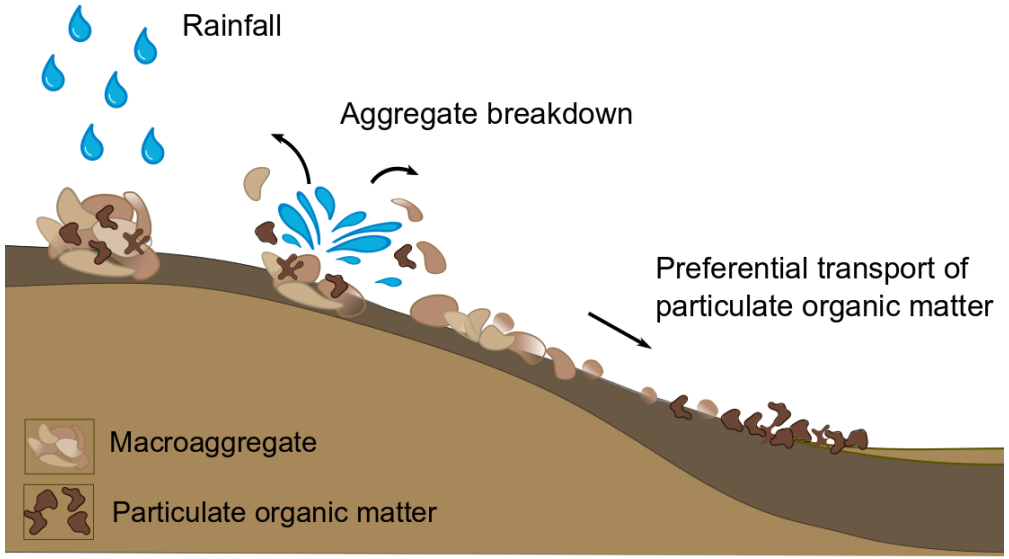
- Carbon, nitrogen and phosphorus contents are around 50% higher in eroded sediments than in the original soils → carbon and nutrients are stored mainly in light or small soil fractions
- How to interpret the increasing C/N ratio in eroded sediments?

	% in SOM	C/N ratio
Mineral associated organic matter (MAOM)	65	12.6
Particulate organic matter (POM)	35	22.1

Cotrufo et al. (2019)

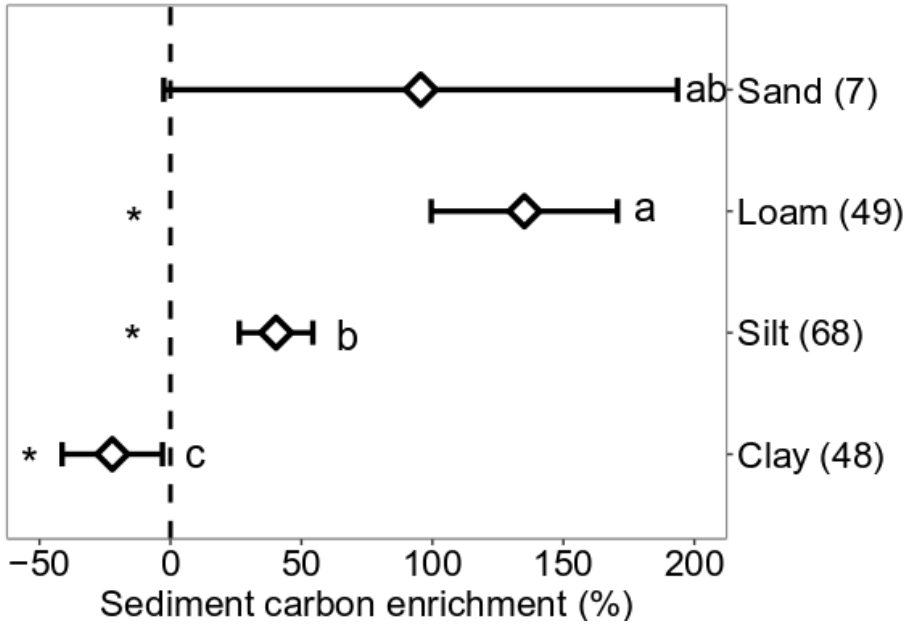
- C/N ratio increases by 10% in eroded sediments
- Based on the share of MAOM and POM in soil organic matter and their C/N ratio, MAOM was depleted by 16% and POM was enriched by 29%

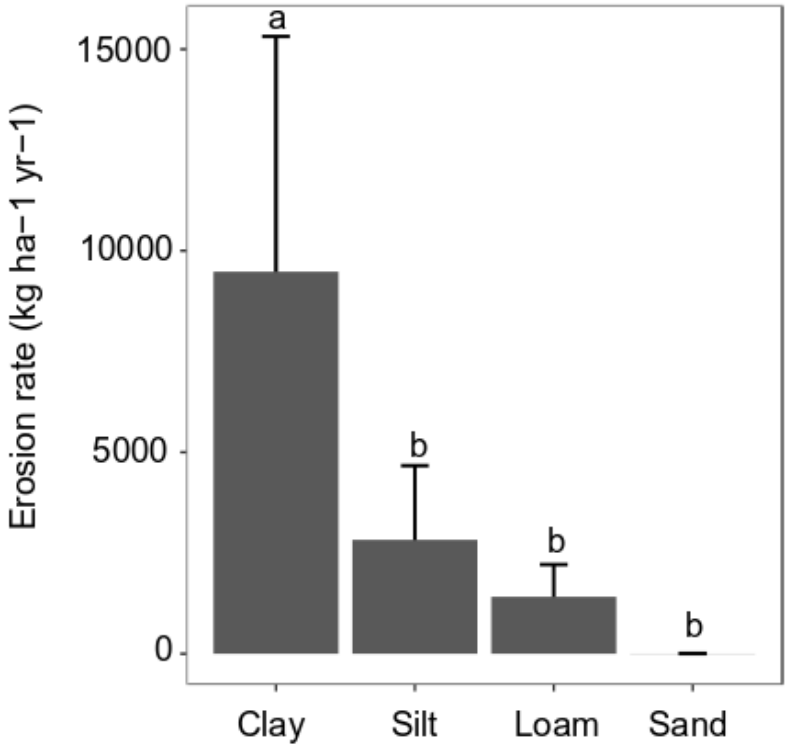
Possible mechanism: breakdown of aggregates and release of particulate organic matter



- Soil organic matter in eroded sediments is more **labile** than soil organic matter in original soil

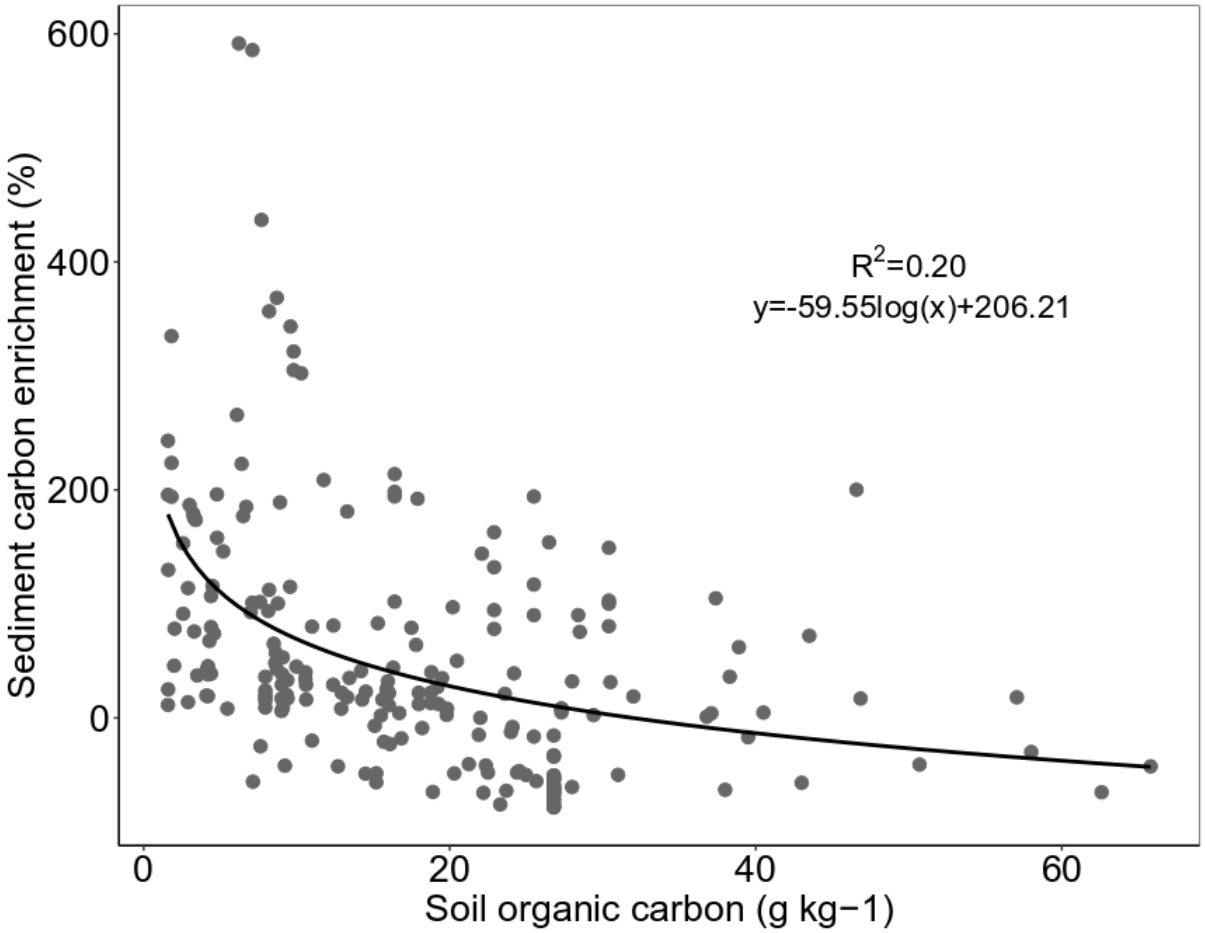
Effect of soil texture on sediment enrichment





- Sediment carbon enrichment decreases with particle size → clay soils contain a smaller share of POM that is particularly enriched
- Decreasing enrichment with particle size is counterbalanced by increasing erosion rates in fine soils → Similar C losses independent of textural class

Relation between soil C content and sediment C enrichment



- Negative relation between soil C content and sediment C enrichment

➢ Soils with low C contents are less aggregated and comprise a greater share of low density, C rich particles (i.e. POM) → this material is easily eroded and therefore enriched in the eroded sediment

Summary and Conclusions

- Eroded sediments are particularly enriched in particulate organic matter and are therefore prone to mineralization of soil organic matter
- Decreasing enrichment with particle size is counterbalanced by increasing erosion rates in fine soils → Similar SOM losses independent of textural class
- Soils with low C contents show high enrichment probably caused by low aggregation and a great share of POM in these soils
  - ➢ Based on this negative relation, soil carbon contents could be used to predict sediment carbon enrichment

Thank you